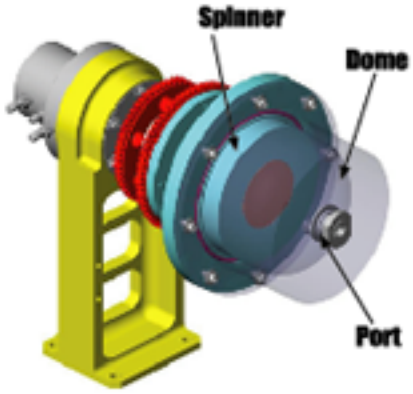
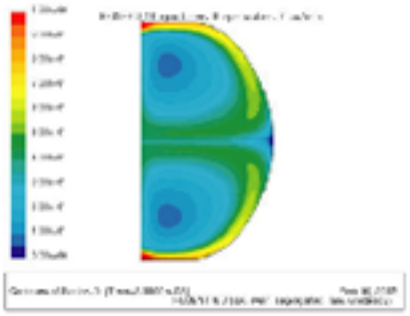
:: SPACE HYDRODYNAMIC FOCUSING BIOREACTOR ::

ADVANCED SPACE BIOREACTOR SYSTEMS

Overview



CAD Model of HFB-S



Computational Fluid Dynamics
Oxygen Concentrations

Description

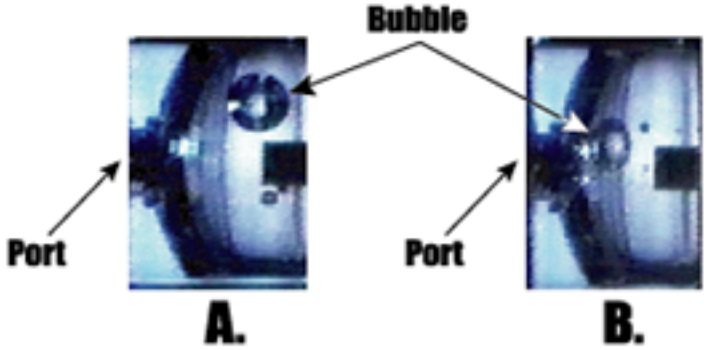
The Space Hydrodynamic Focusing Bioreactor (HFB-S) is a 40ml hemispherical dome-shaped vessel with a central sampling port and an internal rotating spinner. The rotation of the vessel and spinner create a hydrodynamic force within the vessel medium. In space, the hydrodynamic force can be modulated by a change in the rotation rates of vessel dome and spinner to facilitate mass transfer for growth of cells and tissues. Exchange of gases is facilitated by a perfusion loop that moves medium from the vessel into the oxygenator where CO_2 is removed and O_2 is added. Oxygenated medium is returned to the vessel at several entry ports around the periphery of the internal spinner. Medium and biological samples are removed through the central sampling port for observation or processing.

Points of Contact:
Dr. Steve R. Gonda
Dr. Ed Hudson

NASA Significance

The Cellular Biotechnology Program at the NASA Johnson Space Center has successfully developed space bioreactor systems to support on-orbit cell culture and tissue engineering investigations. Space bioreactor systems consist of a culture vessel, oxygenator for exchange of O_2 and CO_2, perfusion/infusion loop, and a sensor array for monitoring pH, glucose and dissolved gases. An Experiment Control Computer (ECC) controls the operation of the Space Bioreactor and archives operational and experimental data to PCMCIA cards. A Gas Supply Module (GSM) delivers required gas mixtures to the bioreactor oxygenator. The Space Bioreactor has successfully supported many space cell culture and tissue engineering investigations, including the longest (>130 days) tissue engineering experiment in space. However, the formations of bubbles in the vessel have impacted the fluid dynamic properties and altered the fluid shear levels, and have been impossible to remove. The significant innovation in the design of the Space Hydrodynamic Focusing Bioreactor (HFB-S) is the controlled generation of a hydrodynamic force to "herd" bubbles to the central sample port for automated or manual removal without degrading the shear-sensitive cell assemblies and tissues.

Bubble Removal In Low Gravity



The ability of the Space HFB to move bubbles to the central sample port for extraction was tested in NASA's reduced gravity aircraft. Bubbles were introduced into the vessel at 1G. During the 20 seconds of low gravity the bubbles align axially and move towards the sample port at the dome apex (Inset A & B). In a subsequent flight, bubbles "herded" to the port were easily removed using a syringe directly mounted to the sample port.